



Expansion of the geographic range of *Cyatta abscondita* Sosa-Calvo et al., 2013 (Hymenoptera: Formicidae)

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Abstract: The presence of the recently described fungus-farming ant genus and species *Cyatta abscondita* is reported in the northwestern region of Misiones Province in Argentina. A single worker of *C. abscondita* was collected in a pitfall trap in a mature plantation of *Pinus taeda* in the Atlantic Forest biome. This finding expands the distribution of the genus and species, extending it farther south in the Neotropics.

Key words: Argentina; Atlantic Forest; *Atta* genus group; fungus growing ants; new record

Cyatta abscondita Sosa-Calvo, Schultz, Brandão, Klingenberg, Feitosa, Rabeling, Bacci, Lopes & Vasconcelos, 2013 belongs to a monotypic genus described recently (Sosa-Calvo et al. 2013), and included within the fungus-growing ants [Myrmicinae: Attini: *Atta* genus group (Ward et al. (2015))]. The fungus-growing ants are a New World monophyletic group (Schultz and Brady 2008) whose geographical range includes southern North America, Central America, South America, and the Caribbean (Mayhé-Nunes and Jaffé 1998; Sosa-Calvo et al. 2015). The centre of origin has been proposed to be in the Amazonia area where the basal genera are found; a later migration occurred to the south where species richness peaked, with the most derived genera originating in a second richness centre (Mayhé-Nunes and Jaffé 1998). To date, the fungus-growing ants comprise 16 genera and more than 250 valid species (Schultz and Brady 2008; Fernández et al. 2015; Sosa-Calvo et al. 2015); 10 genera and 66 valid species have been recorded in Argentina (Fernández and Sendoya 2004).

The fungus-growing ants are characterized by a mutualistic relationship with a fungus (Hölldobler and Wilson 1990). Ants obtain food from the fungus and

the fungus receives a nutritional substrate, protection, and dispersion. The ants use various substrates, such as organic detritus or fresh vegetation, to cultivate their fungus gardens. The fungus-growing ants have been divided into two subclades, the Paleoattini and the Neoattini. The Paleoattini includes three genera: *Apterostigma* Mayr, 1865, *Mycocepurus* Forel, 1893, and *Myrmicocrypta* Smith, 1860, and the Neoattini include the remainder (Schultz and Brady 2008). The fungus-growing ants have also been divided in two groups according to agricultural system: lower and higher fungus farmers. In lower fungus farmers, ants cultivate fungi in the tribe Leucocoprineae (Basidiomycotina: Agaricaceae) which can also live outside the symbiosis (Schultz et al. 2015; Mehdiabadi et al. 2012; Cafaro et al. 2011). In the higher fungus farmers, which includes the leaf-cutting ants (*Acromyrmex* Mayr, 1865 and *Atta* Fabricius, 1804), ants cultivate fungi with a significant degree of domestication as they are obligate symbionts (Schultz and Brady 2008; Cafaro et al. 2011; Schultz et al. 2015).

The most basal groups of Paleoattini and Neoattini are lower fungus farmers. The most derived Neoattini are higher fungus farmers (Schultz and Brady 2008; Cafaro et al. 2011; Schultz et al. 2015). Some exceptions are known to occur: a higher fungus farmer has been found cultivating a lower-attine fungus (Mehdiabadi and Schultz 2009) and a Paleoattini ant has been found cultivating a fungus of the leaf-cutting ants (Schultz et al. 2015). The leaf-cutting ants cut and process fresh plant material such as leaves or flowers, whereas other fungus-growing ant species use a variety of organic detritus, including dead plants and insect faeces (Hölldobler and Wilson 1990; Schultz et al. 2015). Based on molecular data, *Cyatta abscondita* is the most basal species in the Neoattini, and it shares some morphological characters

with the genera included in the Paleoattini (Sosa-Calvo et al. 2013). Because of its phylogenetic position Sosa-Calvo et al. (2013) proposed that it belongs to the lower fungus farmers.

To date, all of the specimens of *Cyatta abscondita* collected are from Brazil, especially from the Cerrado biome, ranging from Campo Limpo to Cerrado *sensu stricto*. Campo Limpo is dry grassland without shrubs or small trees. In Cerrado *sensu stricto* the predominant habitat is woodland, characterized by small trees with canopy lower than 7 m, shrubs, and abundant ground vegetation. The Cerrado climate has a marked dry season from May to September and mean annual temperature and precipitation of 23°C and 1,420 mm,

respectively (Sosa-Calvo et al. 2013). In addition, some specimens of *C. abscondita* have been collected in a relatively undisturbed area of Caatinga, a biome characterized by deciduous thorny woodland and xeric shrub in northeastern Brazil (Sosa-Calvo et al. 2013). The Caatinga climate is hot and dry with a mean temperature of 26°C and a precipitation of 750 mm/year, concentrated in three consecutive months (December to February) during the southern hemisphere summer or summer/autumn (de Queiroz 2006). Finally, a few *C. abscondita* were found in fragments of semi-deciduous forests in northwestern São Paulo state, considered a transition zone between Cerrado and the Atlantic Forest (Sosa-Calvo et al. 2013; Camacho and Vasconcelos

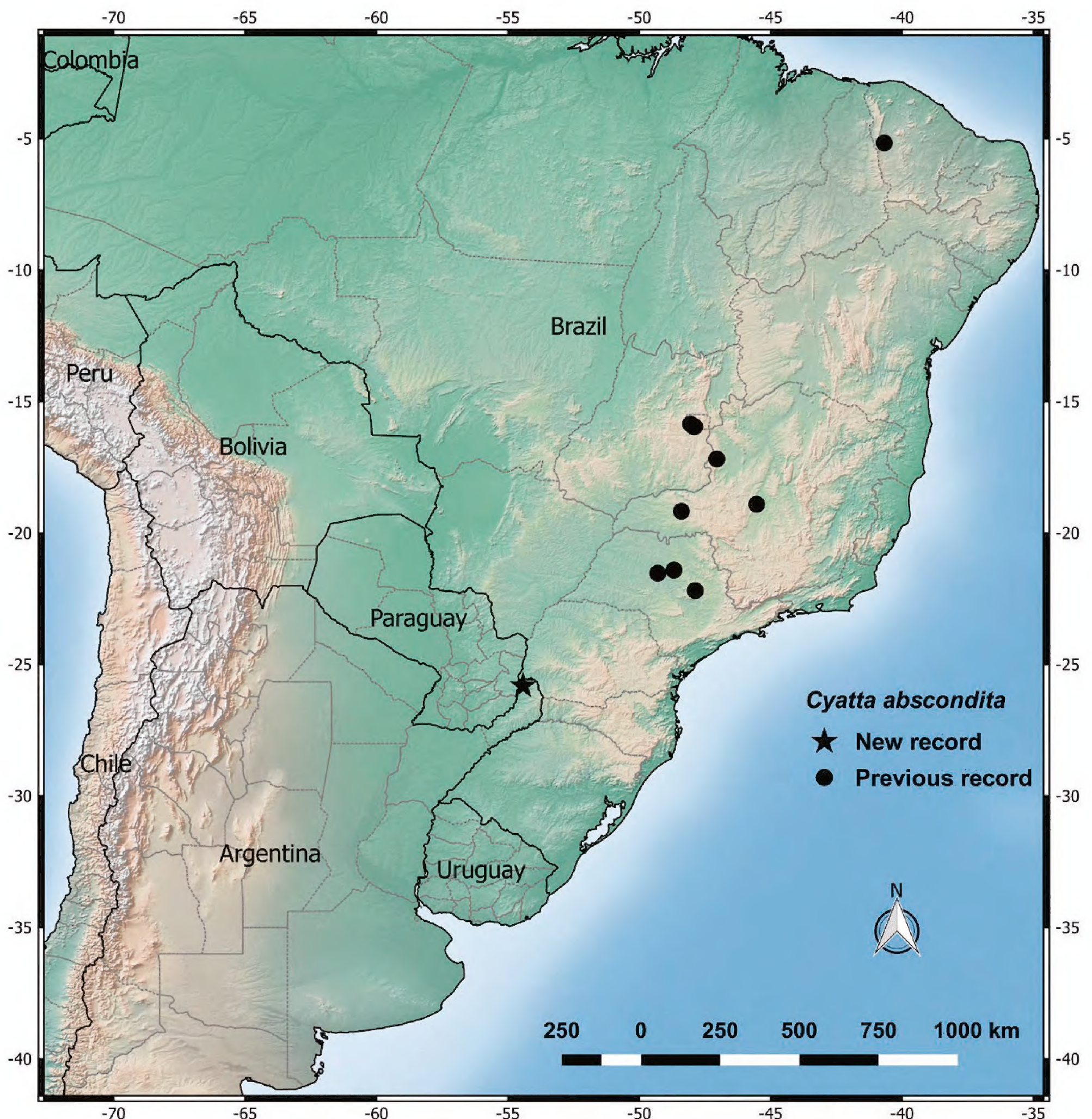


Figure 1. Distribution map of *Cyatta abscondita*. The new record is represented by a star.

2015). In particular, several specimens were collected in human-modified areas such as dirt roads or the lawn near the dormitories at a biological station (Água Limpa, Brasília, Brazil). *Cyatta abscondita* is rarely collected in pitfall traps and leaf-litter samples although it seemed locally abundant in places where it was recorded (Sosa-Calvo et al. 2013).

Here we report the first record of *Cyatta abscondita* in Argentina, extending the known geographic distribution to the South. The specimen was collected as part of a wider study attempting to understand the response of ant assemblages to environmental conditions caused by forest management in human-modified habitats (i.e., *Pinus* sp. plantations).

The study was conducted within the Atlantic Forest biome, a subtropical semi-deciduous native forest in the northwestern part of Misiones Province, Argentina (Figure 1). The native forest is characterized by three to five arboreal strata, epiphytes, and lianas, and an understory composed primarily of ferns and bamboo (Giraud et al. 2003). The climate is subtropical and rainfall is evenly distributed throughout the year, with a cold season between June and August. The mean annual temperature and precipitation are 21° C and 2000 mm, respectively (SMN 2015). The study area consists of areas of continuous native forest in protected areas, native forest fragments of varied size and shape, and commercial tree plantations (Zurita and Bellocq 2010). Plantations are mainly composed of pines (*Pinus taeda* L.), eucalypt (*Eucalyptus* spp.) and the native *Araucaria angustifolia* (Bertol.) Kuntze are also planted for timber.

Ant collections were conducted in mature plantations of *Pinus taeda* during the summer, from December 2013 to March 2014. On each of 24 pine plantations we established a set of three pitfall traps at least 100 m from the plantation edge. Pitfall traps consisted of plastic containers (1,000 ml volume, 100 mm diameter) partially filled with 350 ml of propyleneglycol: water (1:2) solution and inserted flush with the ground. The Misiones provincial government (MERNyT of Misiones, permit no. 813) and Alto Paraná S.A. issued the appropriate permissions for collecting and transporting ants.

Vegetation cover was estimated within a 5 × 5 m² plot following the modified Braun Blanquet scale for plant growth forms (Braun-Blanquet et al. 1979). Percentage coverage was visually estimated, classifying all plants into four growth forms (grasses, herbaceous dicots, ferns, and bushes); percentage cover of leaf litter was also estimated. Canopy cover was estimated using digital photos taken 1.5 m above the ground and the percentages of canopy cover were estimated with Image J (Peyras et al. 2013).

Ant identifications were made using published keys and descriptions for myrmicine ants (Palacio and

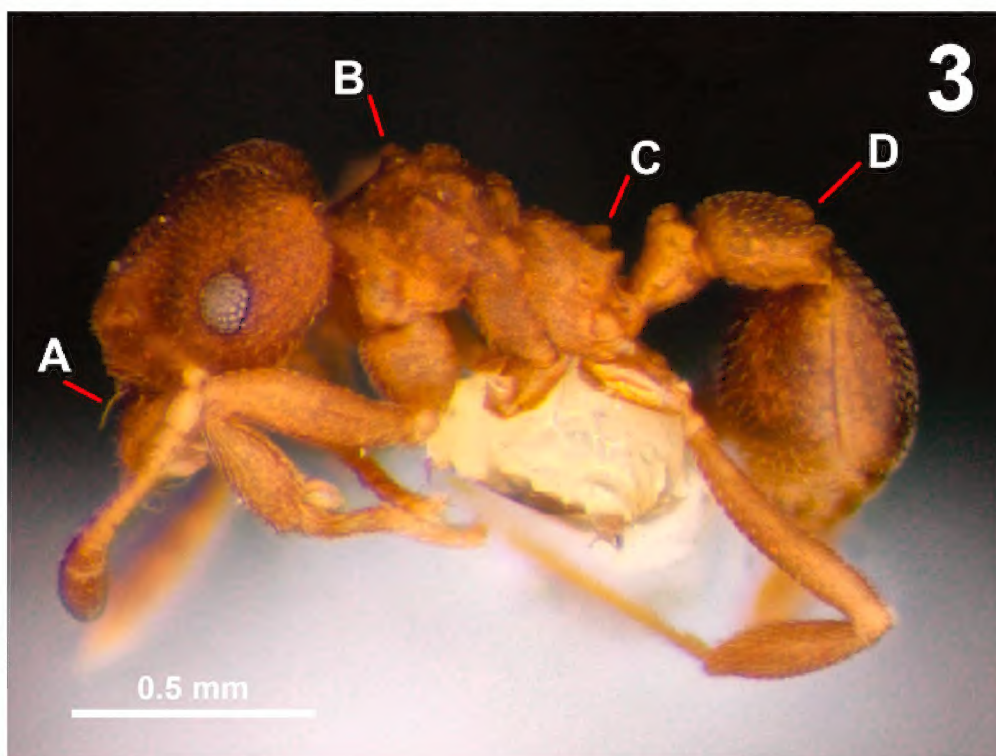
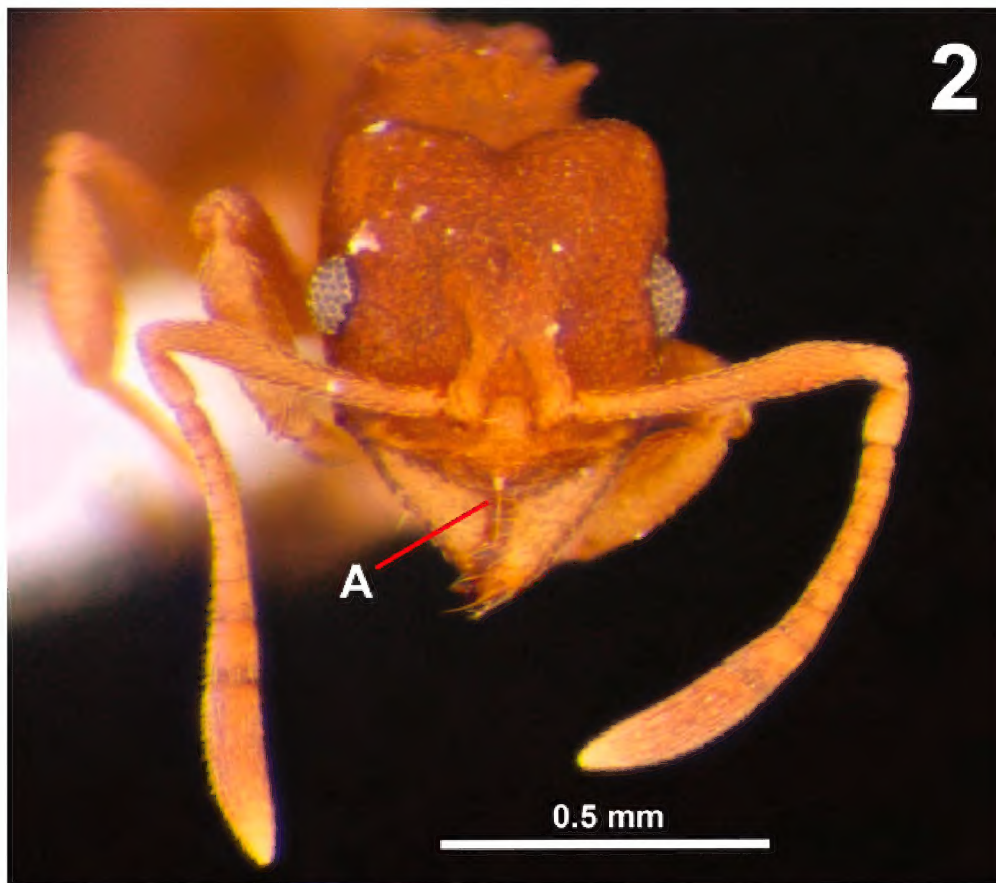
Fernández 2003; Sosa-Calvo et al. 2013). Identification was confirmed using the original description of the species, morphometric measurements, and comparison with photographs of the holotype published in the online database AntWeb (2015).

Photographs were taken using a Carl-Zeiss Discovery V8 stereo-microscope with an AxioCam ERc 5s camera, taking a photo for each plane of focus depth and then processed by the “focus-stacking” technique using Zerene Stacker software (zerenesystems.com/cms/home). To obtain morphometric measurements, photographs were analyzed using Image J software (Schneider et al. 2012) following the protocol used previously for related groups (Sosa-Calvo and Schultz 2010; Sosa-Calvo et al. 2013). We took the following measurements: head length (HL) excluding the mandibles; mandible length (ML); Weber’s length (WL), alitrunk length; petiole length (PL), straight-line distance from the posterior-most margin of the petiole to the posteriormost margin of the metapleural lobe; maximum postpetiole length (PPL); gaster length (GL); scape length (SL) excluding the basal condyle; eye length (EL), the maximum diameter of the eye measured from the dorsal margin to the ventral margin; frontal lobes distance (FLD), maximum horizontal distance between the outer borders of the frontal lobes. Total length (TL) was calculated as the sum of HL+ML+WL+PL+PPL+GL; cape index (SI) was calculated as (SL/HL) × 100; mandibular index (MI) was calculated as (ML/HL) × 100.

A total of 5,997 ants were collected, including a single worker of *Cyatta abscondita*. The specimen was captured at a 9-year-old plantation. The point-mounted specimen was deposited in the Insect Collection of the Community Ecology and Macroecology Laboratory at the Universidad de Buenos Aires; and bears the unique identifier number SAS0586. Vegetation cover in the plantation was almost 100% pine needles, 1.5% grasses, 8.15% herbaceous dicots, 30% ferns, 1% shrubs, and 82% canopy cover.

The studied specimen shared all the diagnostic characters for the genus *Cyatta* (Figures 2–4), as described by Sosa-Calvo et al. (2013). *Kalathomyrmex* Klingenberg & Brandão, 2009, together with *Cyatta* form the sister group of the remaining Neoattine ants (Sosa-Calvo et al. 2013). Our specimen exhibits all diagnostic characters of the only known species: *C. abscondita*. The most relevant characters of the specimen are: integument reticulate and uniformly light yellow color; head, in full-face view, subrectangular with subparallel sides; masticatory margin of the mandibles four-toothed; anterior margin of clypeus with convex clypeal apron and with a long unpaired median seta that arises closer to its posterior margin (Figures 2A–3A); psammophore absent; antennae 11-segmented; frontal lobes reduced and rounded;

dorsum of mesosoma with short, attenuate, and blunt tubercles (Figure 3B); propodeum with a pair of short triangular spines that are slightly higher than in the type (Figure 3C); node of petiole high, well-developed;



Figures 2–4. Specimen (worker) captured of *Cyatta abscondita* SAS0586. **2:** Full-face view. **3:** Lateral view. **4:** Dorsal view. Red lines point to diagnostic characters. A: Clypeus with long median seta. B: Mesosomal dorsum with tubercles short, attenuate, and blunt. C: Propodeum with a pair of short triangular spines. D: Postpetiole with simple appressed hairs.

dorsum of head, mesosoma, petiole, and postpetiole covered with simple appressed hairs, but less abundant in mesosoma (Figures 3 and 4). A more comprehensive description and diagnosis of this species can be found in Sosa-Calvo et al. (2013). The measurements (in mm) are: TL 2.47; WL 0.66; HL 0.55; HW 0.53; SL 0.5; ML 0.34; EL 0.1; PL 0.15; PPL 0.24; GL 0.53; CI 96; SI 101; MI 62; FLD 0.19. In general, these measurements and indices are within the expected range compared to measurements of the holotype. We did not find any morphological variation that differentiates this specimen with the populations described from Brazil.

This is the southernmost record for *C. abscondita*, extending the species' range about 700 km south. This is also the first record of the species for Argentina, raising the country's number of fungus-growing ant genera to 11 and the number of species to 67. This finding extends the distribution of the species into a colder Neotropical habitat.

Furthermore, this is the first record for the species within the Atlantic Forest biome. The Cerrado and Caatinga biomes, where it was previously found, have a dry season that is absent in the Atlantic forest. Thus, our finding suggests that *Cyatta abscondita* is a Neotropical species adapted to inhabit a wide range of biomes and ecoregions, including different climatic regimens. That implies the species distributional range could be even larger than is currently known.

Our specimen was found in a human-altered habitat. Previous collections were also made in human-altered habitats (Sosa-Calvo et al. 2013). Forest replacement is an activity that involves working machines, land movements, vegetation removal, etc. It is possible that *C. abscondita* is a habitat generalist that tolerates and even benefits from human habitat modification, as do leaf-cutting ants (Hölldobler and Wilson 1990). Sosa-Calvo et al. (2013) proposed that the species might be abundant but hard to capture with traditional collecting methods (including pitfall traps). As we used pitfall traps and collected only one specimen, it is possible that we are underestimating the presence of *C. abscondita* in *Pinus* sp. plantations.

The Atlantic Forest is a biodiversity hot-spot and the ant fauna of Misiones is highly diverse (Hanisch et al. 2015). Increasing sampling efforts will help to further describe the ant fauna and their ecological functions in this threatened biome.

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